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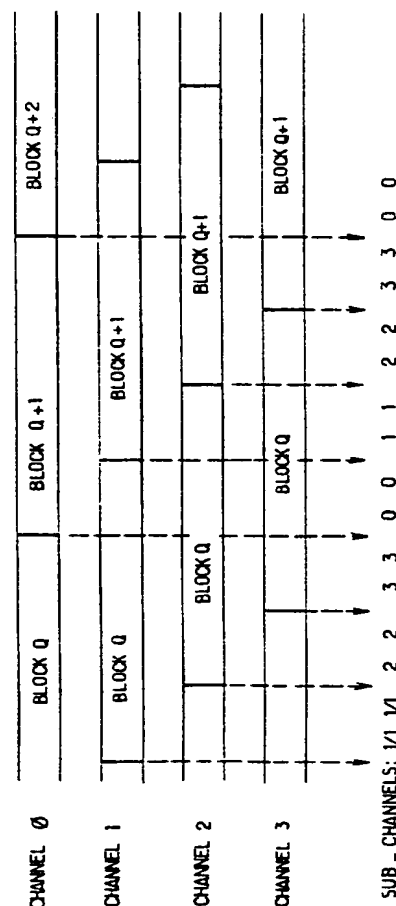
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(54) **TDMA radio-communication method.**

(57) According to the method, a physical transmission channel is split into a plurality of logic channels which may be dedicated to different communications. Each logic channel consists of time slots having a same duration and the same rank in successive frames of constant length. At least one of the logic channels is split into a plurality of sub-channels dedicated to different communications. Groups of k successive time slots (k being an integer greater than 1) are allocated to each logic sub-channel. The groups are time distributed in a regular way and k is so selected that N be different from $(m.k+1)$ where m is an integer and N is the number of time intervals necessary for reconstructing an information block.

FIG.1.



BACKGROUND OF THE INVENTION

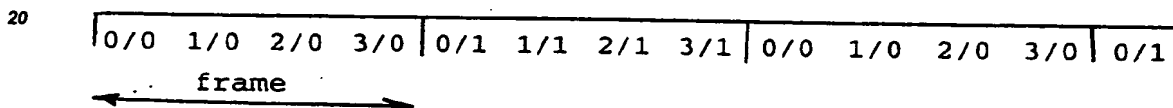
The invention relates to time division multiple access digital radio-communication systems known as TDMA, wherein a physical transmission channel is time-divided into a plurality of logic channels which may be assigned to different communications, each logic channel consisting of time slots having a same serial number in successive frames of constant length.

There may be data or voice communications which do not require the maximum rate or "full rate" authorized by a logic channel. It has already been proposed to divide a logic channel into a plurality of sub-channels, (two subchannels for example).

In frequent cases, reconstruction of a part of message cannot be carried out before all bits representing that part have been received. This situation exists when the communication is coded with an error detection or correction code or crypted.

Half-rate transmission is conventionally achieved by assigning a time slot having a predetermined number to one of the sub-channels in the odd frames and the same time slot to the other sub-channel in the even frames. The transmission delay which results from the time duration required for receiving a given number of bits is then doubled. It is still increased when a logic channel is divided in more than two sub-channels.

For instance, with a multiplex of order $p=4$ with $n=2$ subchannels per logic channel, the sequence of dedications is as follows, with i/j designating the j th sub-channel of the i th channel:



It can be seen that the time distribution of the allocated time slots remains regular, but the time period necessary for completely transmitting a data block which was available just before appearance of a dedicated time slot (for instance 0/0) increases and may be doubled in certain cases.

More generally, with:

N: number of time slots necessary for recovering the whole information or data constituting a block,
 30 T_T : duration of a time slot,
 p: the order of the multiplex,
 n: number of sub-channels per channel,
 R_T : transmission delay,
 then:

$$R_T = [(N - 1) \cdot n \cdot p + 1] T_T \quad (1)$$

Oftentimes, the time delay should not exceed a maximum value for being acceptable. For voice transmission it should not exceed about 500 ms.

Formula (1) can be generalized to the transmission of voice data with interleaving of a plurality of blocks for protection. Then N represents the number of time slots required for interleaving.

In the following frequent references will be made to implementation of the invention in a GSM communication system, with time division and slow frequency hopping, where transmission is carried out in successive frames of eight time slots each of 577 μ s, each time slot comprising 156,25 bit periods and having a useful length of 147 bits. It is however also applicable to time division multiplex systems of orders (for example 4) and, although it has then less interest, to systems without frequency hopping.

In a GSM system in accordance with recommendation GSM 0502 of June 1991, to which reference may be made, the digitally encoded voice channel are designed for authorizing either "full rate" or "half rate". Data transmission may also be provided for "full rate" and "half rate", the full rate and half rate channels respectively corresponding to gross rates of 22,8 and 11,4 Kbits/s. According to the recommendation, transmission in "half rate" is in accordance with the above-identified approach, which was felt preferable because it provides a completely homogenous time division between the radio-electric resources.

A number of documents exist which indicate how to insert a variable flow of data on a transmission medium, but do not deal with the problem of communication delay. Reference may for instance be made to 39th IEEE Vehicular Technology Conference, May 1-3, 1989; San Francisco, U.S.; Vol. 2, pages 712-717; A. Maloberti: Radio Transmission Interface of the Digital Paneuropean Mobile System.

SUMMARY OF THE INVENTION

It is an object of the invention to decrease the transmission delay suffered by communications transmitted

on logic sub-channels having a reduced rate without increasing the transmission delay for the other sub-channels. It is an ancillary object of the invention - when communications are faced with fading problems - to achieve a compromise which is close to optimum between the desirable decrease in the transmission delay and the desirable reduction of the detrimental effect of perturbations which are time or space localised.

For this purpose, there is provided a digital transmission method of the above-defined type wherein at least one of the logic channels is divided into a plurality of sub-channels dedicated to different communications, characterized by assigning specific groups each of k successive time slots (k being an integer greater than 1) to each logic sub-channel, said groups being regularly time distributed and k being so selected that N be different from $(m.k+1)$ where m is an integer and N is the number of time slots necessary for reconstructing an information block.

Then the transmission delay for a sub-channel may be written as:

$$R_T = [E((N-1)/k).k.n.p + \text{MOD}(N-1, k) + 1]T_T \quad (2)$$

where:

- $E(X)$ designates the integer part of X ,

- $\text{MOD}(N-1, k)$ designates the residual part of $N-1 \bmod k$.

Formula (2) indicates that the gain G on the delay R_T is maximum when $\text{MOD}(N-1, k)$ is maximum, i.e. when: $N = 1.k$, 1 being an integer.

Then the maximum gain G_M , as compared with the condition illustrated by formula (1) is:

$$G_M = (K-1)(n.p-1).T_T \quad (3)$$

More generally, a non zero gain G is obtained each time k is greater than 1. For $N=k7-i$ (with 1 being an integer and i being an integer fulfilling the condition $k-1 > i > 0$):

$$G = (k-i-1)(np-1).T_T \quad (4)$$

The condition for obtaining a non zero gain may also be written as $i \neq k-1$, or $N \neq mk+1$ (m being a positive integer).

The selection of k will typically result from a compromise which will depend from the characteristics of the physical transmission channel.

First of all, k should be sufficiently low for not unduly delaying the sub-channels other than the sub-channel which is favored.

When transmission occurs on perturbed channels (toward mobile stations or from mobile stations for instance), it is preferable not to locate the interleaved pieces of information or data belonging to a same block too mutually close; that constraint disappears when transmission occurs with frequency hopping, as for GSM, since the propagation conditions between two successive time slots are then uncorrelated.

Additional constraints may exist, in relation with the transmission system.

For instance the GSM does not make it possible to modify the distribution of the time slots allocated to each physical channel, due to the time necessary for transmission-reception switching in the mobile stations, such switching involving frequency changes required by slow frequency hopping transmission.

It is however possible, without modifying the allocation of the time slots to logic channels, to modify the allocation of the time slots for each logic sub-channel and to decrease the time duration required for full transmission of a block.

For simplification, the case of a multiplex of order 4 with two logic sub-channels per channel, already mentioned, may be considered. Then the above constraint authorizes the following grouping with $k=2$:

| | | | | | | | | |
|-----|--|-----|--|-----|--|-----|--|-----|
| 0/0 | | 0/0 | | 0/1 | | 0/1 | | 0/0 |
|-----|--|-----|--|-----|--|-----|--|-----|

Again, i/j designates the j th sub-channel of channel i .

If the above constraint had not existed, then the distribution could have been:

| | | | | | | |
|-----|-----|-----|-------|-------|-----|-----|
| 0/0 | 0/0 | --- | 01/01 | 01/01 | --- | 0/0 |
|-----|-----|-----|-------|-------|-----|-----|

When the digital communication method is of the above-defined type but does not include all constraints of the GSM system, alternative methods are possible. In a method applicable when the whole information carried on the different sub-channels emanate from a same source, all subchannels of a same channel are processed as a same information flow, corresponding to only one logic channel. Then transmission on the radio channel is carried out without dedicating the time slots to a specific sub-channel. A time slot then carries information belonging to a plurality of sub-channels.

A more complete understanding of the invention will be obtained from the following description of particular embodiments, given only as examples. The description refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic representation of a possible implementation of the invention with a multiplex of order 4, with $k=2$;

5 Figure 2 is a simplified drawing illustrating a conventional frame structure for a GSM system with subchannels, including a logic control channel;

Figures 3 and 4 are illustrations of schemes according to the invention suitable for use with GSM having multiframes of twenty-six frames (respectively for voice frames of 20 ms and 30 ms);

10 Figure 5 is a scheme illustrating a possible scheme when omitting one of the GSM constraint, but with control channels;

Figures 6 and 7 are simplified block diagrams indicating the basic components of the transmission and reception parts of a TDMA base station.

Figures 8 and 9, similar to Fig. 6 and 7, are simplified block diagrams indicating a possible construction of the transmission and reception parts of a mobile station in a TDMA system.

15 Figures 10 and 11 are block diagrams indicating a possible construction of modules found in Fig. 6-9.

Figures 12-18 are block diagrams indicating various possible implementations of the invention in a base station.

DETAILED DESCRIPTION OF EMBODIMENTS

20 Referring to Figure 1, there is shown a scheme for implementing the invention with a time multiplex signal of order 4, with four channels, with $k=2$ and one sub-channel per logic channel. Blocks numbered Q, Q+1, Q+2, ... are mutually offset by a time corresponding to one quarter of a time slot in the different channels. The last line of the figure indicates the distribution of the sub-channels. In the particular case which is illustrated, 25 $k=2$ successive directly adjacent time slots are attributed to the same subchannel, thereby decreasing the time period necessary for reconstructing one block.

The time transmission delay is then as given by formula (2) and the gain on time is as given by formula (4). It is higher than zero as long as i differs from $k-1$, or that N differs from $mk+1$, m being an integer.

30 As already indicated, a specific reference will be made to transmission methods including the constraints of GSM. For simplicity, a simplified notation will be used which omits indication of the time slots dedicated to the logic channels other than that which is considered. If for instance reference is made to channel 0, the successive time slots will be written as:

0/0 0/0 0/1 0/1 0/0 0/0 0/1 0/1 0/0

35 rather than:

40

| | | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0/0 | (1) | (2) | (3) | 0/0 | (1) | (2) | (3) | 0/1 | (1) | (2) | (3) | 0/1 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|

The transmission delay R_T is then given by the following formula (2bis) where N represents the number of time slots required for interleaving:

$$R_T = [E((N-1)/k).k.n.p + \text{MOD}(N-1, k).p + 1]T_T \quad (2\text{bis})$$

$$45 \quad G = (k-i-1).(n-1).p.T_T \quad (4\text{bis})$$

The time gain G , as given by formula (4bis), is:

- maximum and equal to $G_M = (k-1)(n-1)p.T_T$, for $i=0$,
- zero for $i=k-1$, which should consequently be avoided.

50 With GSM as defined by the above-mentioned recommendation GSM 05-02, an additional logic channel called SACCH (Slow Associated Control Channel) is inserted within the sequence of slots.

The frame structure is then as given in Figure 2, where the time slots allocated to other traffic channels are omitted. On Figure 2, S0 and S1 respectively designate the logic channels SACCH of physical channels 0 and 1.

The delay R_T is then

$$55 \quad R_T = (N.n.p + 1)T_T \quad (1\text{bis})$$

In formula (1bis), the term $N.n.p+1$ is due to the presence of the additional logic channel.

The presence of channel SACCH does not prevent grouping, in groups of k time slots, the time slots allocated to a same sub-channel.

However, the condition for determining an optimum value for k is slightly modified.

If L is the number of data elements to be transmitted and M is the number of data elements carried as a burst during one time slot, then preferably $k = L/M$. That value of k should be an integer. If the data to be transmitted are delivered steadily, then that value of k provides conditions of transmission which are optimum and which are equitable for all flows of communication, i.e. do not detrimentally affect some of them as regards the transmission delay.

That approach results to the structures illustrated in Figures 3 and 4 for voice frames, respectively for $k=2$ and a frame duration of 20ms and for $k=3$ and a duration of 30 ms.

With that type of structure, the time delay R_T becomes:

$$R_T = [E(N-1)/k] \cdot k \cdot n \cdot p + p + \text{MOD}(N-1, k) \cdot p + 1] T_T \quad (2\text{ter})$$

The time gain as compared with the regular structure illustrated in Figure 2 is then:

$$G = [(k-i-1)(n-1)p + p] T_T \quad (4\text{ter})$$

Then k is selected for obtaining:

$$k-1 \geq i \geq 0$$

$$\text{for } N = k \cdot i.$$

Then the gain is:

maximum and equal to $[(k-1)(n-1)p + p] \cdot T_T$ for $i=0$;

minimum and equal to $p \cdot T_T$ for $i=k-1$.

As a typical example, with half-rate GSM (i.e. with $k=2$), for frames of 20ms and interleaving of depth 4 or 6, with $T_T=0.577$ ms and $p=8$, the gain is:

$$G = 9.2 \text{ ms.}$$

For half-rate GSM and voice frames of 30 ms, $k=3$ and interleaving of depth 3, the gain is $G = 13.8$ ms.

Again for half-rate GSM and frames of 30 ms, but with interleaving of depth 5, the gain is $G = 9.2$ ms.

The above-described method is applicable to the up-link (mobile toward base station) as well as to the down link of a system using TDMA frames. If however one of the constraints of GSM is disregarded, the down link offers a supplemental possibility which does not exist for the up-link, since all pieces of information from the down-link originate from the stationary station, consequently from only one source which may easily synchronize all frames in all radiofrequency channels.

Then all sub-channels of a same channel may be considered as equivalent to an undifferentiated set of data which may be interleaved on all time slots available for that channel.

In other words, it is possible to process all subchannels as a same channel and to interleave all data originating from different sub-channels. All data are then transmitted as a same flow and the time slots need not be dedicated to a specific sub-channel.

The structure of Fig. 4 then is changed to that of Fig. 5 and corresponds to the full rate (with the exception of channels S_0 and S_1).

Then the time delay may be written as:

$$R_T = (N \cdot p + 1) T_T \quad (2\text{quater})$$

and there is a gain G_1 as compared with the scheme of Fig. 2:

$$G_1 = N(n-1)p \cdot T_T$$

That gain G_1 is $N \times 4.6$ ms for GSM with $n=2$ and $p=8$.

As compared with the schemes of Fig. 3 and 4, there is a gain G_2 :

$$G_2 = [N - k + i + 1](n-1)p \cdot T_T$$

where $N = k \cdot i$ and $k-1 \geq i \geq 0$.

For interleaving of depth 4 and frames of 20 ms:

$$G_1 = 18.4 \text{ ms}$$

$$G_2 = 9.2 \text{ ms}$$

For interleaving of depth 6 and frames of 20 ms:

$$G_1 = 28.6 \text{ ms}$$

$$G_2 = 18.4 \text{ ms}$$

For interleaving of depth 3 and frames of 30 ms:

$$G_1 = 13.8 \text{ ms}$$

$$G_2 = 0 \text{ ms}$$

For interleaving of depth 5 and frames of 30 ms:

$$G_1 = 23 \text{ ms}$$

$$G_2 = 13.8 \text{ ms.}$$

In the present day condition of the recommendations applicable to GSM, that possibility is however not available since the discontinuous transmission method would only be active when there are no data to be transmitted simultaneously on both sub-channels, thereby removing the advantage.

Other constraints present in the GSM system, or more generally in systems using a discontinuous transmission (for instance voice transmission), such as the fact that the beginning of each TDMA frame in the up link is delayed in the base station, e.g. by three time slots, with respect to the beginning of the frame in the down link, while the delay is variable in the mobile stations, are however without any incidence.

It would not be necessary to give a full description of particular means for implementing a system carrying out the method according to the invention. The method only requires a dedication of the data blocks to be transmitted on different sub-channels which is different from those conventionally used and that dedication may be carried out with software while the hardware may be one of those already known. However, some indications will now be given with reference to Figs. 6-18.

First of all, and for illustration purpose, a global representation of the components is given in Fig. 6 as regards the transmission side and in Fig. 7 as regards the reception side of a base station. The corresponding structures are respectively illustrated in Fig. 8 and 9 for transmission and reception when only one logical channel (or sub-channel) is present. Such a case exists in the mobile station of a TDMA radio system.

In Figs. 6 and 7, the indicia attached to the reference numbers do not indicate the order in which the various channels will be communicated to the output. Different rank orders are used conventionally and according to the invention.

Referring to Figs. 6 and 7, each module 11_i is for forming a logical channel (or sub-channel) and may be as described in Fig. 10. The output of module 11_i (with i being equal to 1, ..., pxn) consists of successive bursts each in a time slot. One original information block is carried by a fixed number of successive time slots. Module 12_i fulfils the interleaving function. It receives bursts each having the length of a time slot at the input thereof, interleaves the information of each burst on a plurality of time slots, and outputs interleaved time slots with the same format as at the input.

This function may in some applications be completely transparent.

At the output of module 12_i, the original information block is spread over N successive time slots. The module 3 is a multiplexer and the invention applies more specifically to this module.

The inputs of module 13 are connected to the outputs of the different modules 12_i. Each input is formatted in the same way, with successive time slots. The module 13 multiplexes the inputs by reading one time slot from each successive input in sequence. After T_T it connects the next input and delivers it on a single output which drives the physical channel. The module 13 then connects the next input after T_T . Consequently module 13 builds the TDMA structure. The output of module 3 feeds the modulator 14 of a transmitter for broadcast to a distant station. When module 13 has processed its (pxn)th input (last input), it reverts to the first input.

In the arrangement illustrated in Fig. 8, a single channel (or sub-channel) is present. This is the case of a mobile station where a logic channel (or sub-channel) must be transmitted in TDMA. Then multiplexer 23 scans its different inputs in succession. Most inputs are not active and correspond to logic channels (or sub-channels) that are not actually used at the mobile station but correspond to communications carried on the physical channel and inserted by other mobile stations present in the system.

When there is no data present at an input, multiplexer 23 does not deliver an output on the physical channel and nothing is transmitted to the distant station during the time slot duration (T_T). When on the other hand information is present at the respective input (L th input in Fig. 8), one burst in one time slot originating from modules 21_L and 22_L is transferred from the input to the output of multiplexer 23, and then to modulator 24.

Figure 7 gives a global scheme of the receiving side. The functions are symmetric of the functions present at the transmitting side. Module 15 achieves the demodulation function (symmetric of the modulation function of module 14) and delivers the demodulated data formatted in time slots or bursts.

Module 16 is a demultiplexer (symmetric of module 13). At frequency $1/T_T$, module 16 transfers the burst of an input time slot to one output, and then directs the next to the following output. After the last output (output pxn), it again directs toward the first output. The outputs are formatted in time slots. Modules 17_i perform the de-interleaving function (symmetric to that of module 12_i). It receives and delivers bursts in time slots. The modules 18_i (as for instance described in detail in Fig. 11) give the desired information from the bursts occupying time slots output by the modules 17_i.

Figure 9 is quite similar to Figure 7 but corresponds to only one active logical channel (or sub-channel). The system operates similarly. A difference is that module 26 delivers an output only when it is switched on the only active output (M). It delivers no output in the other cases.

The scheme of Figures 7 and 9 can be extended to more than one active channel (or sub-channel).

Referring to Fig. 10, module 11 may contain a source module 29 (for example speech source or data source). The digital output of module 29 is formatted in frames and is input to a module 30 that carries out either a source encoding function (e.g. for speech or image), or formatting of incoming information (e.g. for data transmission) or both functions. The output of module 30 is applied to module 31 that carries out channel encoding for protection against errors that may appear on the transmission medium (e.g. radio transmission). The output

of module 31 consists of coded frames. Module 12 receives the coded frames or "blocks" and distributes each block in N time slots. The coded frame has a constant number of elements time slots. The output of module 32 is consequently formatted in time slots.

The construction of Fig. 10 may apply either to one logical channel, (if there is no sub-subchannel), or to one logical sub-channel.

Referring to Figure 11 a typical module 28 may include a first module 33 which receives the time slots and, after reception of N time slots, assembles them and delivers a block to the 34 after de-formating. The module 34 performs the channel decoding function and delivers a coded frame to module 35 for source de-coding (e.g. for speech decoding or image decoding) and/or de-formating (e.g. for data transmission). Module 36 constitutes a sink and receives estimated information for output.

Again Fig. 11 is applicable either to a logical channel - if there is no sub-channel - or to a logical sub-channel. The rank ordering of the inputs of module 13 is now presented in different configurations implementing the presentation of the invention.

Various implementations of the invention will now be given with reference to Figs. 12-17, wherein it will be assumed that the multiplexing module 13 selects its inputs from the top to the bottom in sequence (the same being true for module 16).

In a conventional TDMA system, the channels would be selected in that order. For clarity, any index x, y, z will designate module x for logic channel y and sub-channel z.

Referring to Fig. 12, an implementation of a TDMA scheme will be given which takes into account constraints on logical channel ordering but no constraint on sub-channel ordering in which the transmission delay is reduced by applying the invention.

Figure 13 illustrates a possible implementation of a TDMA scheme with no constraint on logic channel ordering and no constraint on sub-channel ordering, again with reduction of the transmission delay according to the invention.

Figure 14 illustrates a possible implementation of a TDMA system according to the invention without all constraints of the GSM system. Data from different sub-channels of the same logical channel are mutually interleaved together. The implementation is given for four logical channels and two sub-channels per logical channel.

The embodiment of Fig. 14 includes a supplemental module 37. Module 37 is a multiplexer similar to module 13 but with only two inputs connected to two modules 11 for forming in time slots. For instance module 37_i (i being the rank of logic channel) delivers multiplexed time slots to module 12.

Referring to Fig. 15, a possible implementation of the 26 superframe structure of the GSM system in conformity with recommendation GSM 05-02 of June 1991 is given. However only one logic traffic channel is represented with two subchannels on Fig. 15.

There are two traffic sub-channels TCH/0 and TCH/1 and the corresponding "slow" associated control channels SACCH/0 and SACCH/1.

A reference x_{Tz} designates module x for sub-channel TCH/z (Nz equals 0 or 1), and $x_{S Nz}$ means module x for sub-channel SACCH/z (z equals 0 or 1). Fig. 15 is to be compared with Fig. 2.

Fig. 16 gives an optimized implementation of a 26 superframe GSM structure according to the invention for speech frames of 20 ms, to be compared with Fig. 3.

Fig. 17 gives an optimized implementation of a 26 superframe GSM structure according to the invention for speech frames of 30 ms, to be compared with Fig. 4.

Last Fig. 18 gives an optimized implementation of a 26 superframe GSM structure according to the invention when the sub-channels of the same logical traffic channel can be interleaved. This solution omits the constraint on the VAD/DTX mode of the GSM.

Claims

1. Time division multiple access digital radio-communication method, comprising the steps of: distributing a physical transmission channel into a plurality of logic channels each consisting of time slots having a same duration and a same rank in successive frames of constant length;

dividing at least one of the logic channels into a plurality of sub-channels dedicated to different communications; and

assigning specific groups of time slots to each of the successive time slots (k being an integer greater than 1) to each logic sub-channel, said groups being regularly time distributed and k being so selected that N be different from (m.k+1) where m is an integer and N is the number of time slots necessary for reconstructing an information block.

2. Method according to claim 1, wherein k is equal to N/I , where I is an integer.
3. Method according to claim 1 for partial rate communication, wherein said dedication of the sub-channels is carried out without modifying the time slots dedicated to the logic channels as compared with full rate communication and wherein the k time slots of a same group are separated by the duration of a TDMA frame.
5
4. Method according to claim 1 for partial rate communication, wherein $k = L/M$ where L is a number of data elements to be transmitted and M is a number of data elements transmitted during one time slot.
- 10 5. Method according to claim 4, further comprising inserting an additional control logic channel in the sequence of time slots of each physical channel.
6. Method according to claim 1 for partial rate communication, further including the step of inserting an additional control logic channel within the sequence of time slots of each physical channel, wherein k has
15 such a value that N may be written as $I.k-i$ where I is an integer and $k-1 > i > 0$.
7. Method according to claim 4, wherein $k = N/I$.
8. Time division multiple access digital radio-communication method, including the steps of:
20 time dividing a physical communication channel into a plurality of logic channels assignable to different communications, each logic channel consisting of a sequence of time slots having a same serial number in successive frames of constant length,
 time dividing at least one of the logic channels into a plurality of sub-channels carrying data originating from a same source capable of mutually synchronizing said data;
25 processing all sub-channels of a same channel as a same information flow, corresponding to only one logic channel; and carrying out on a radio channel without dedicating the time slots to a specific sub-channel, each time slot carrying data regarding a plurality of sub-channels of the same logical channel.
9. Method according to claim 8, comprising the additional step of inserting an additional control logic channel
30 within the sequence of time slots of each physical channel.

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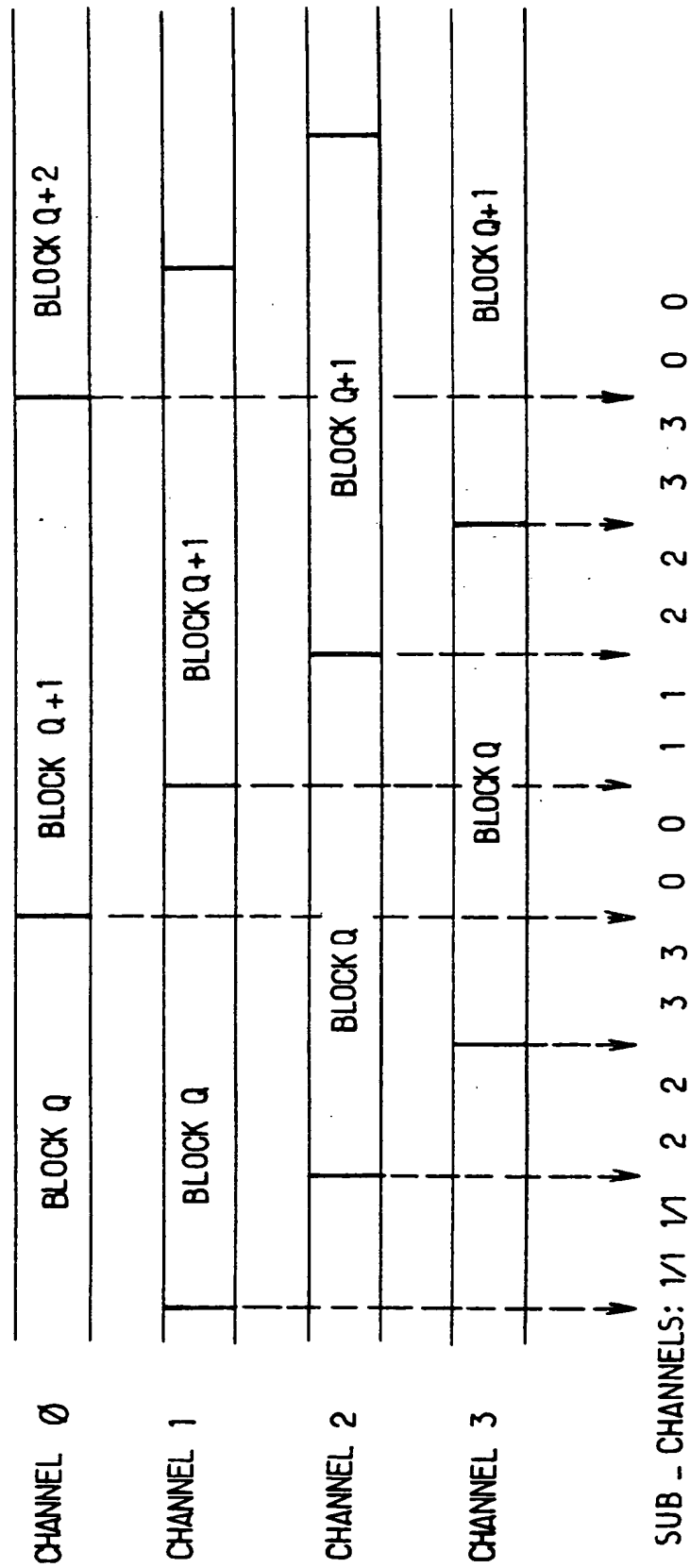
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FIG.1.



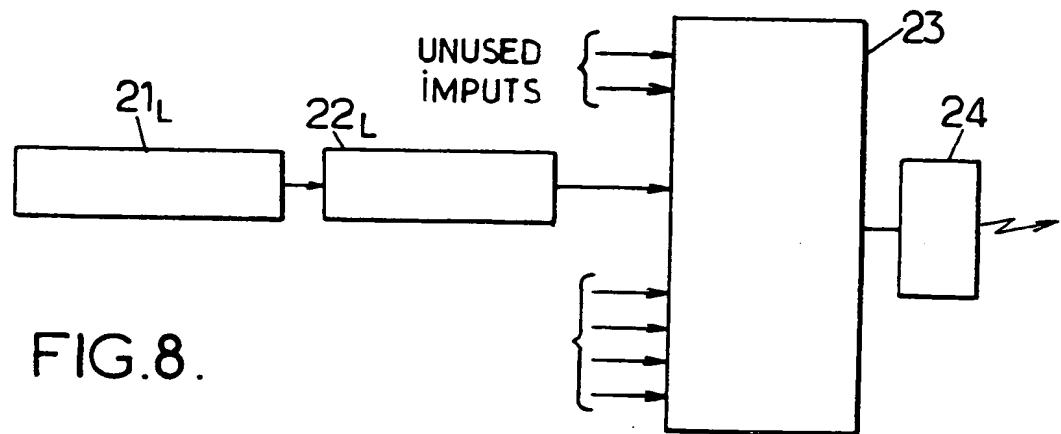
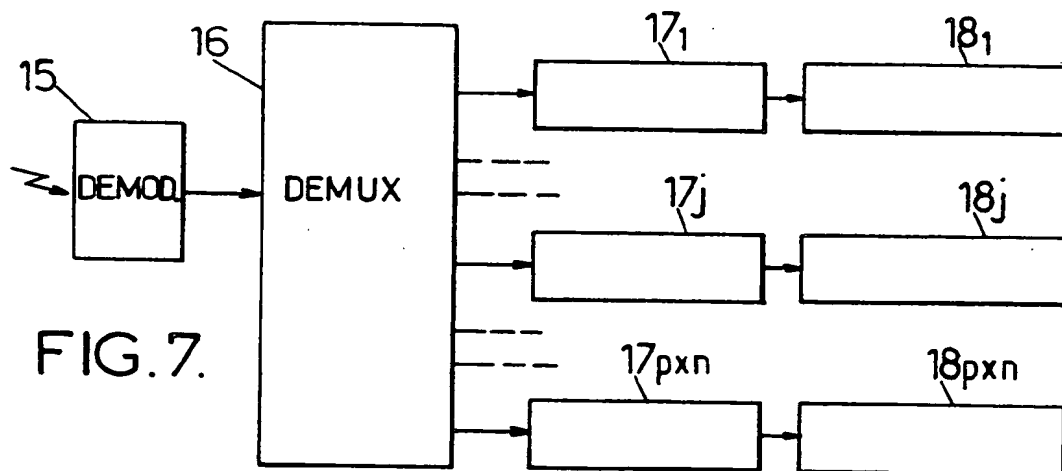
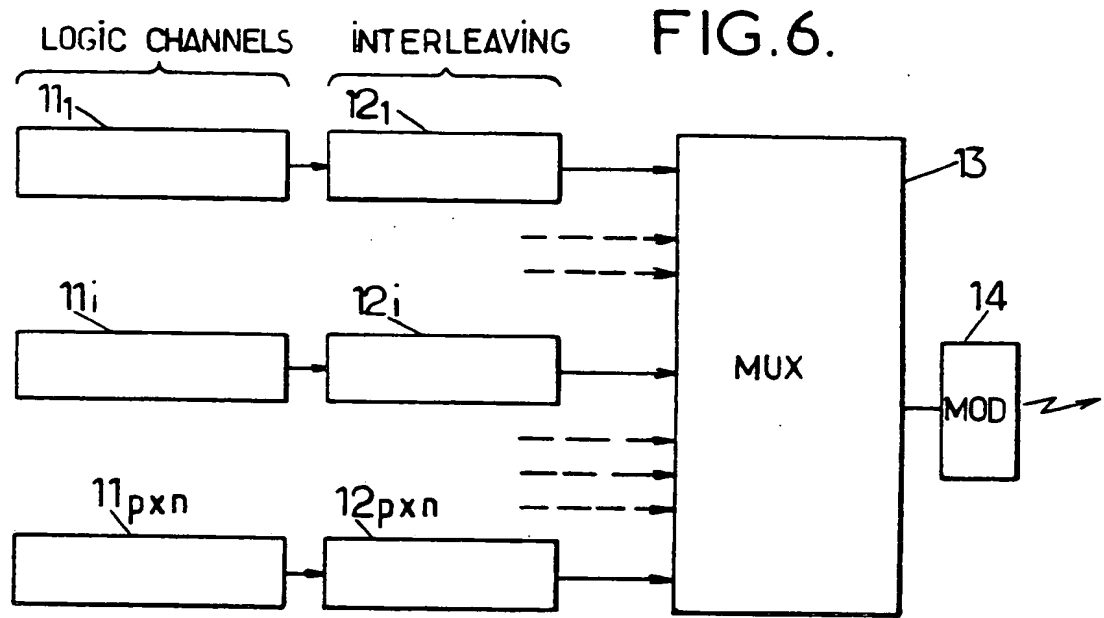


FIG.9.

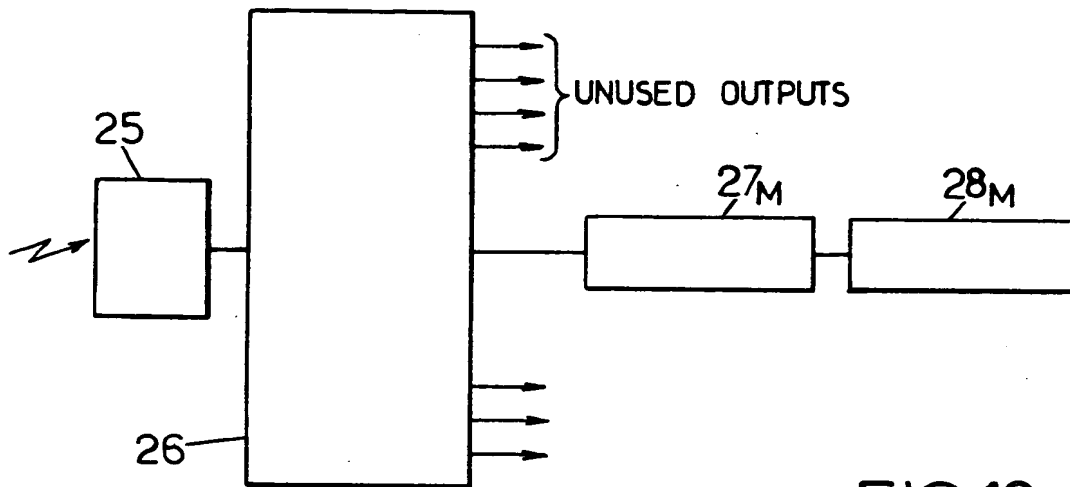


FIG.10.

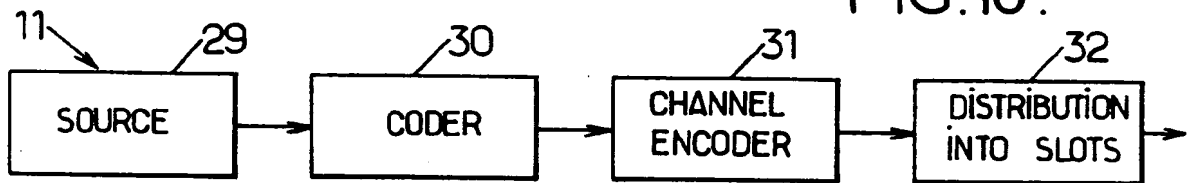
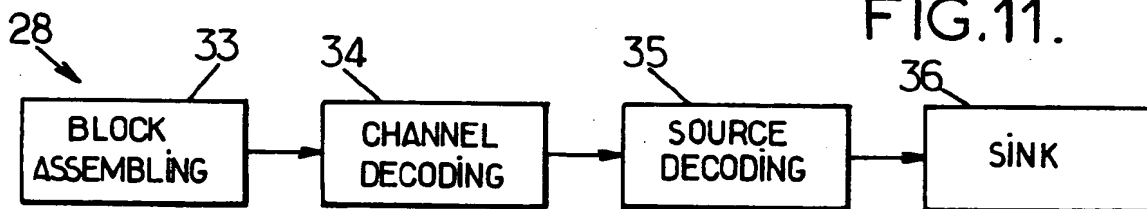
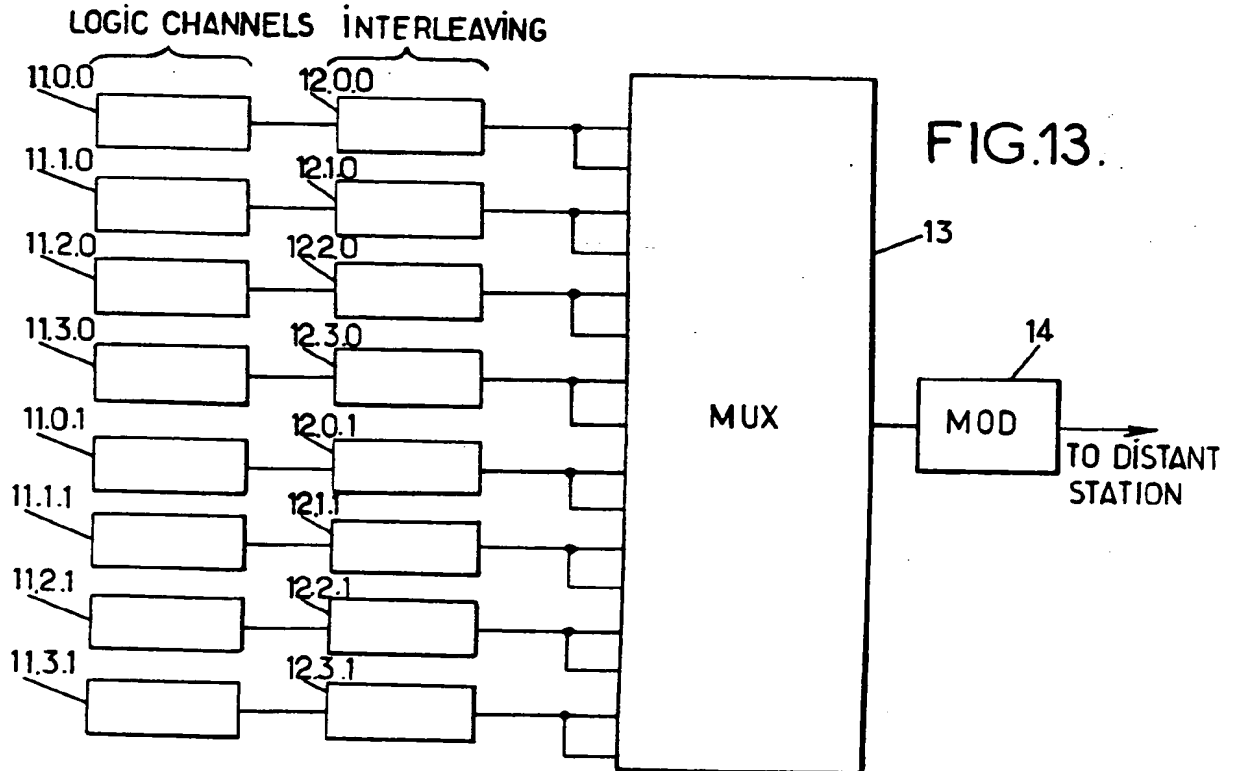
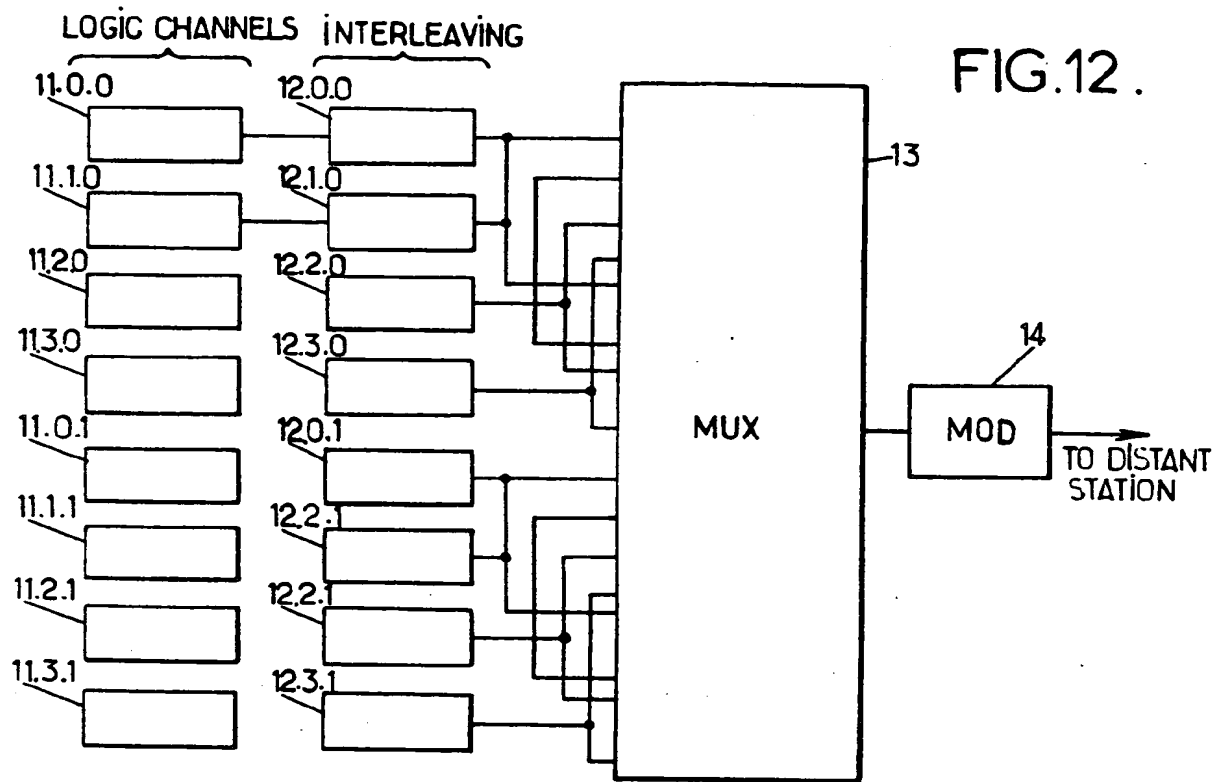
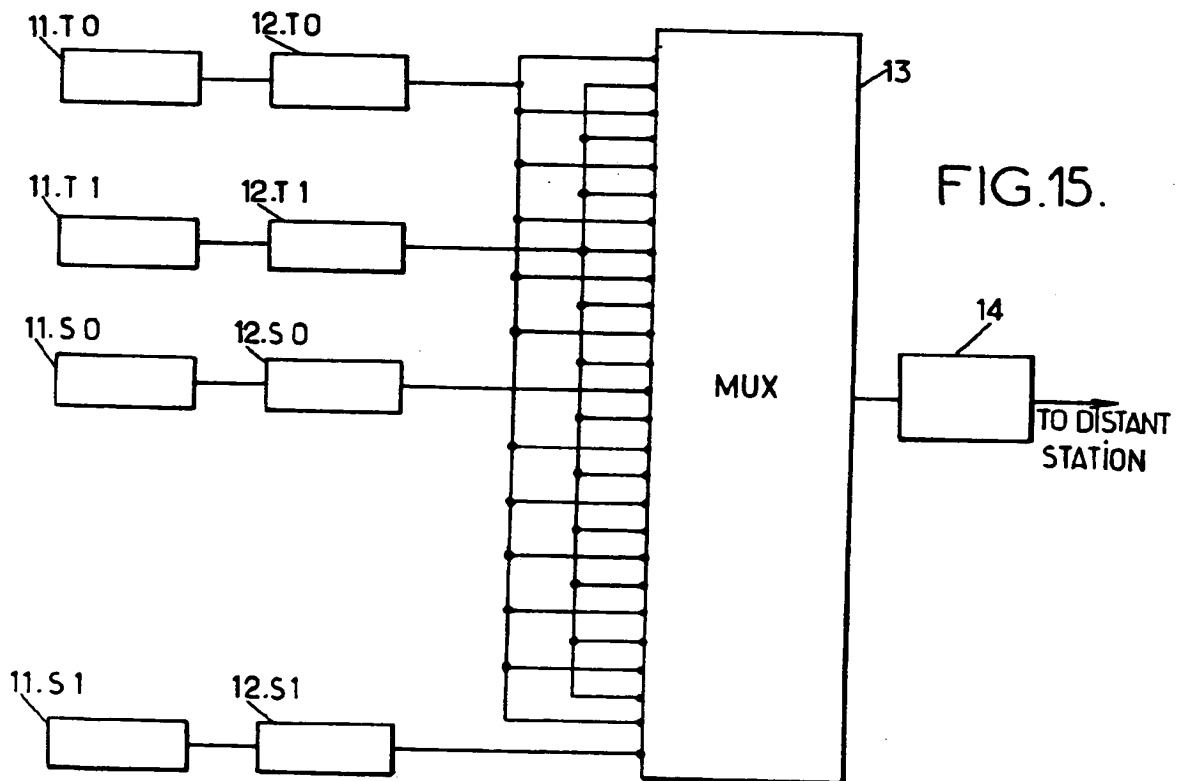
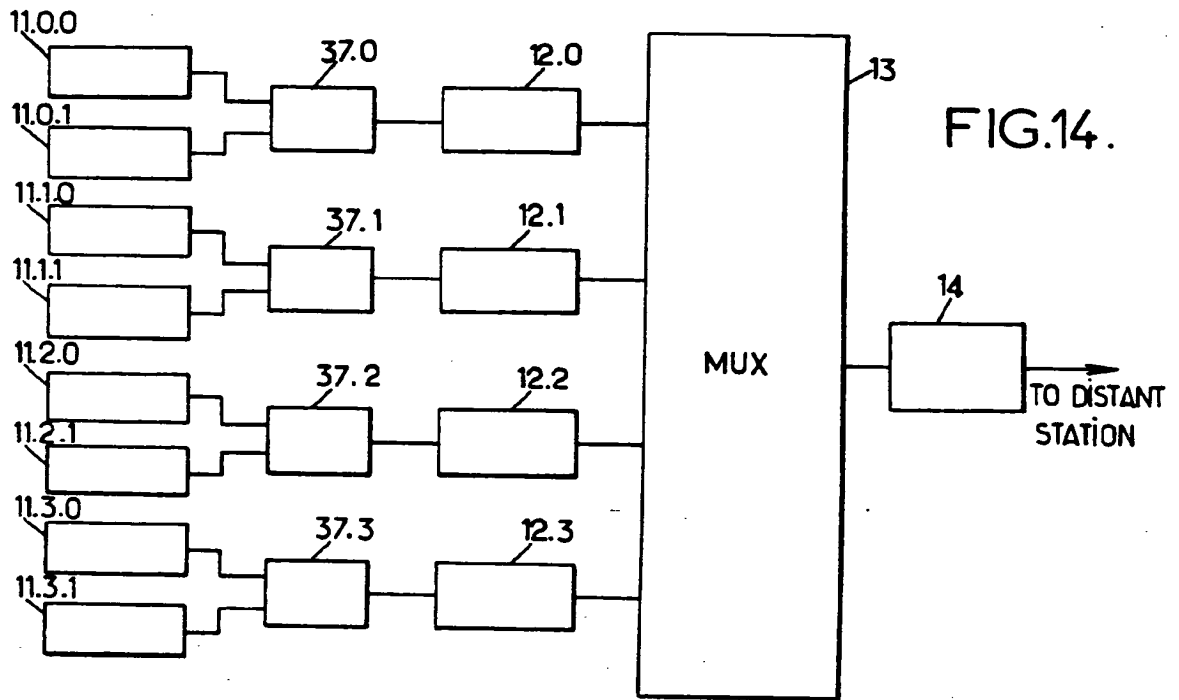


FIG.11.







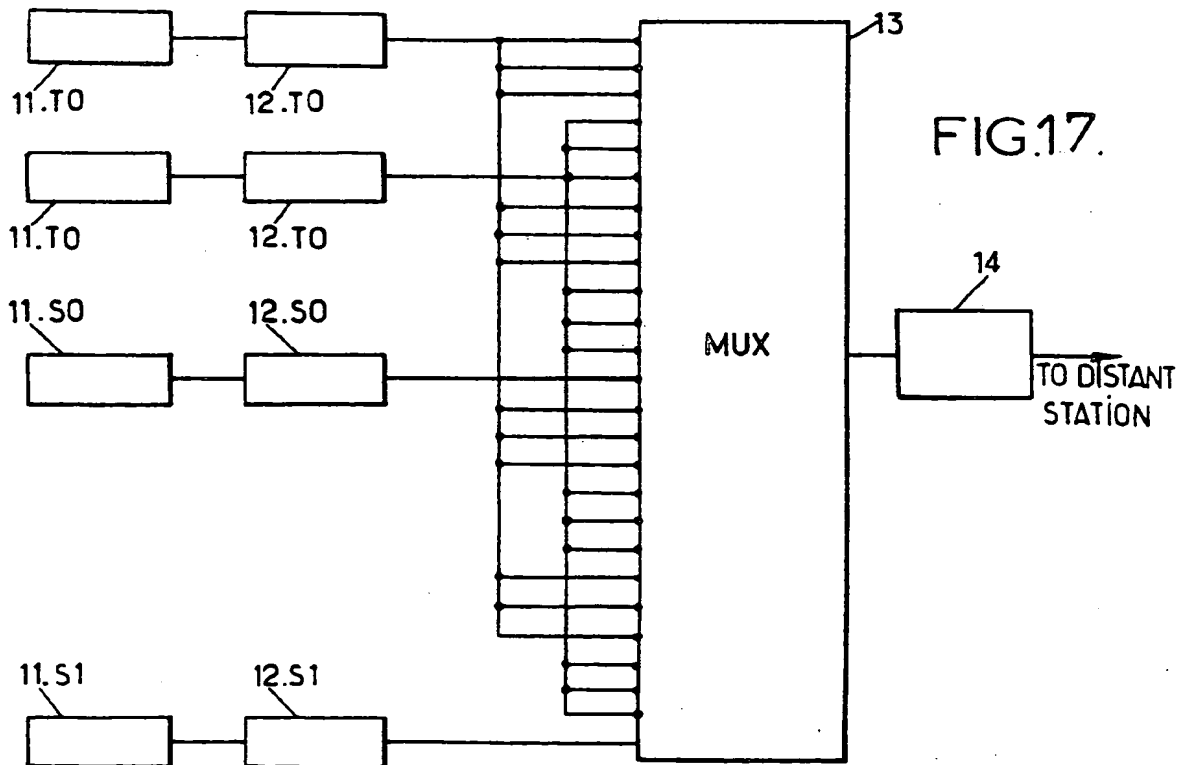
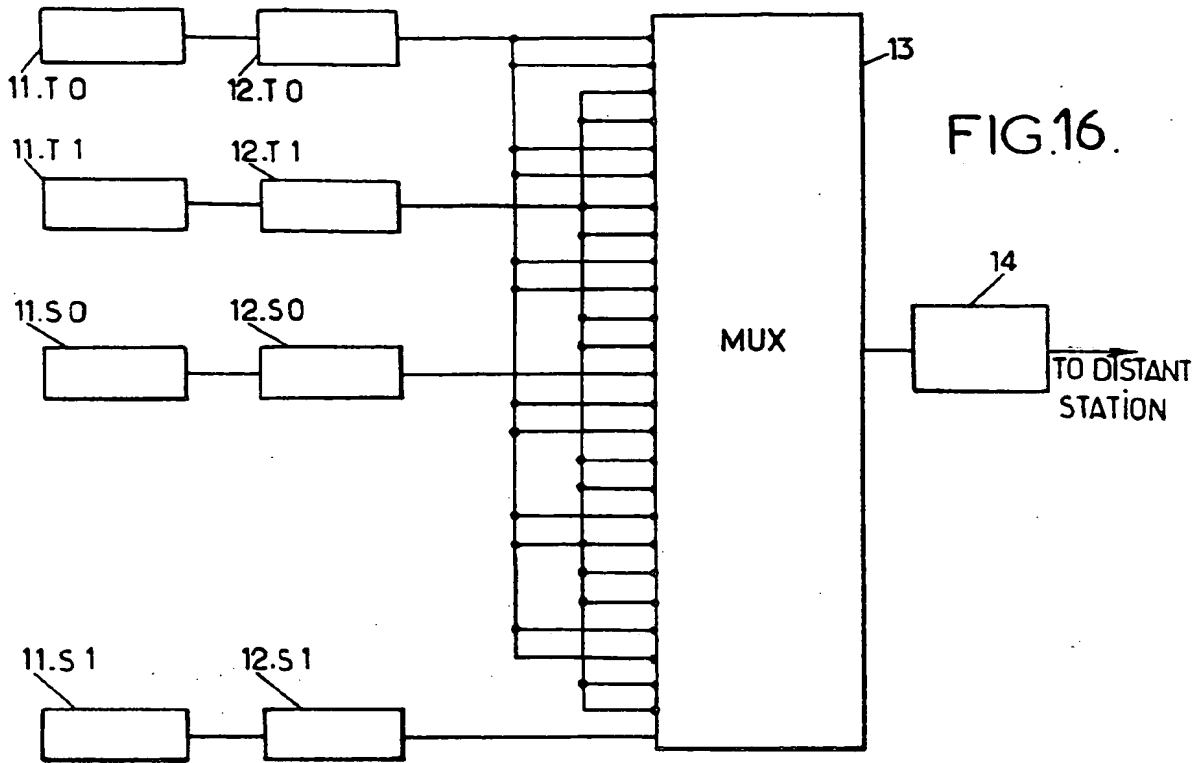
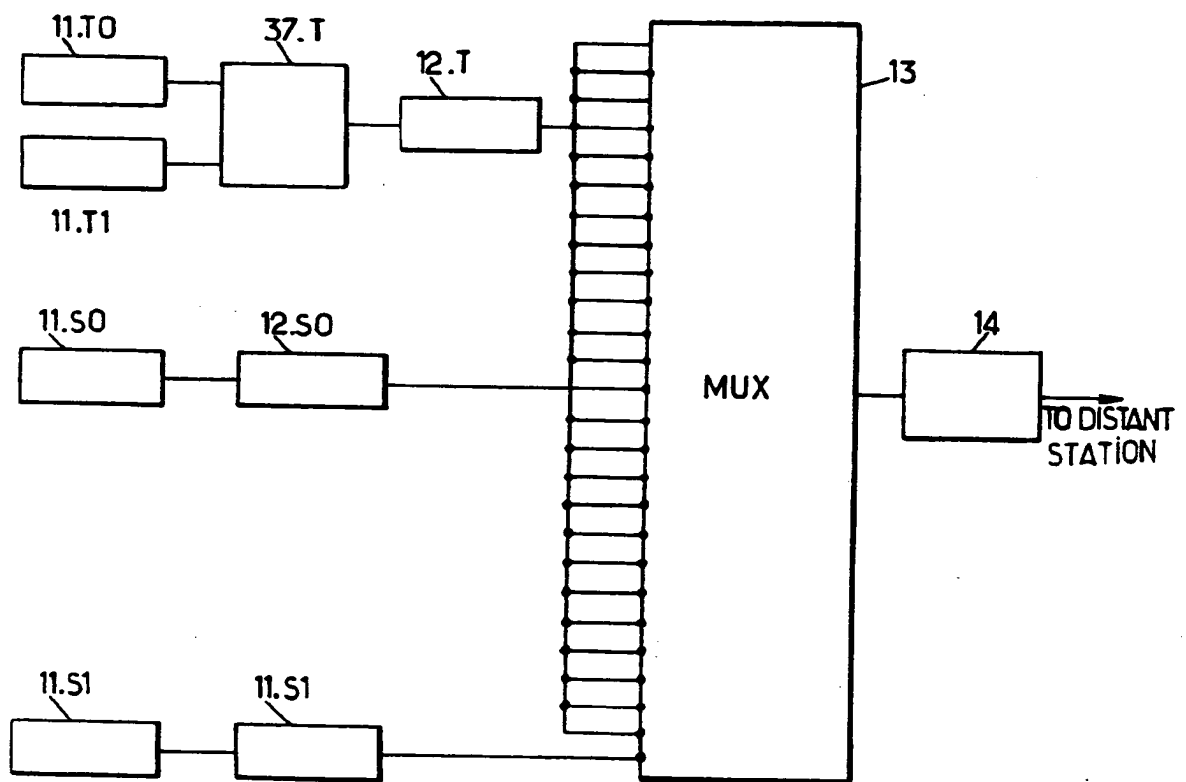


FIG.18.





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 93 40 0793

| DOCUMENTS CONSIDERED TO BE RELEVANT | | | |
|---|--|--|--|
| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
| A | INTERNATIONAL SWITCHING SYMPOSIUM 1987 PHOENIX, US ; 15 - 20 MARS , 1987 PAGES 759 - 765 P. ROBERT ET AL. : ALCATEL LAND MOBILE SYSTEM CD900 A FULLY DIGITAL CELLULAR APPROACH USING WIDEBAND TDMA * page 760, right column - page 761, left column, paragraph 3.1 * | 1,3,5,8, 9 | H04J3/16 H04Q7/04 H04J3/00 H04L5/22 H04B7/26 |
| D,A | 39th IEEE VEHICULAR TECHNOLOGY CONFERENCE 1-3 , MAI , 1989 ; SAN FRANCISCO , US ; VOL. 2 , PAGES 712 - 717 ; A. MALOBERTI : RADIO TRANSMISSION INTERFACE OF THE DIGITAL PANEUROPEAN MOBILE SYSTEM * page 713, right column, line 1 - line 49; figures 1-4 * | 1,5,6,8, 9 | |
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| The present search report has been drawn up for all claims | | | |
| Place of search THE HAGUE | | Date of completion of the search 15 JUNE 1993 | Examiner PIEPER T. |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p> | | | |

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